

BIRD EGGS AND BONES FROM THE MIOCENE OF THE SELVAGENS ISLANDS¹

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RESUMEN

Se citan por primera vez fósiles de aves para las islas Salvajes, Portugal. La presencia de huevos y huesos indica la nidificación en este archipiélago de posiblemente tres especies distintas de pardela durante el Mioceno. Una de estas especies -representada por un huevo fósil y un fragmento de hueso- tenía una envergadura similar a la de *Puffinus puffinus* o *P. mauretanicus*. Por otro lado, trozos de cáscara de huevo y fragmentos de huesos mal preservados, sugieren también la existencia en estas islas de otra especie de ave marina mucho más grande y de otra más pequeña.

Palabras clave: aves fósiles, Mioceno, *Puffinus*, islas Salvajes.

ABSTRACT

Avian fossils are reported for the first time from the Selvagens Islands, Portugal. Egg shells and bone fragments document the breeding of possibly three petrel species in this archipelago during the Miocene. One bird documented by a fossil egg and by bone fragments had the size of *Puffinus puffinus* or *P. mauretanicus*. Shell fragments and poorly preserved bone fragments also suggest the former existence of much larger and smaller bird species in the islands.

Key words: Avian fossils, Miocene, *Puffinus*, Selvagens Islands

1. INTRODUCTION

Selvagem Grande is the largest (4.5 km²) and highest (151 m) island of the Selvagens archipelago. The basement of the island is formed by a conglomerate of fonolitic tuffs and intrusions of fonolitic and plutonic rocks, crossed by numerous fonolitic and basaltic dikes. Its age is estimated between 24-27 m.y. Overlaying this matrix is the so-called "miocenic sediment complex" (GAGEL [4]), formed by fossil marine sediments with a variable thickness between 5 and 10 m. The upper part of the island is a plateau covered by pliocenic lapilli and basaltic lava flows.

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Avian remains were discovered in compacted sands of the “miocenic sediment complex”, located in the Enseada das Pedreiras at an altitude of 70 m (site 1), by A. Santos and L. Sánchez-Pinto in 1999. Further avian remains were found north of this locality at a lower level (65 m, site 2), by F. García-Talavera and L. Sánchez-Pinto in 2000. They represent the first fossil vertebrate remains from this archipelago. BÖHM [3], who reported on some fossils from similar sediments of the Selvagens Islands, dealt with molluscs only.

Both expedition to the Selvagens Islands (1999, 2000) were part of the project “Macaronesia 2000”, supported by the Museo de la Naturaleza y el Hombre (Santa Cruz de Tenerife, Canary Islands).

2. MATERIAL AND METHODS

The fossil eggs and bones were collected using standard paleontological methods. The thickness of the egg shells was measured with a digital caliper. The fine structure of the shells was studied under a Hitachi S-2460 N scanning electron microscope. Voucher samples were deposited in the paleontological collections of the Zoologisches Forschungsinstitut und Museum Alexander Koenig (Bonn, Germany) and the Museo de la Naturaleza y el Hombre (Santa Cruz de Tenerife, Canary Islands).

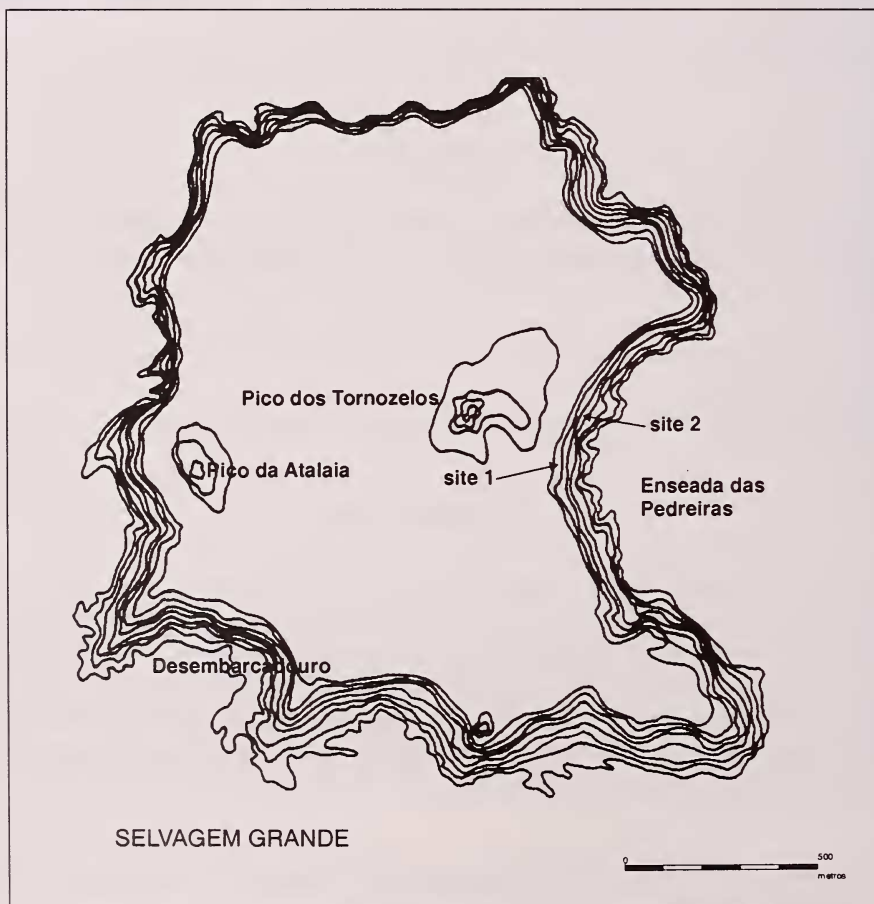


Figura 1. Situation of the avian remains in the miocene deposits.

3. RESULTS

Site 1 (Enseada das Pedreiras, 70 m)

An almost complete egg embedded in matrix (fig. 2), together with fossils of marine bivalve molluscs. Eggshell completely degraded; only a white powder remains which allows to distinguish the egg shell from the surrounding consolidated sand matrix. The egg is oval and measures 61 x 40 mm. The Shape Index is 65.6, which is well within the range of genus *Puffinus* (WARHAM [15]). The egg was compared with egg measurements of 17 species of *Puffinus* and 2 species of *Calonectris* (from SCHÖNWETTER [10] [11], plus own data). The egg from Selvagem Grande falls into the variation of *Puffinus puffinus* (n=6), *P. mauritanicus* (n=1), and into the upper range of variation of *P. yelkouan* (n=14).

Site 2 (Enseada das Pedreiras, 65 m)

Eggshells

Large and small pieces of eggshells were found in the sediments of site 2. Most of them are blackish in colour, some also pale to dark brown. Most pieces are smaller than 1 cm², and all are encrusted by minerals. Measurements of the thickness of 45 fragments shells with fairly clean edges fall into three size classes; the largest has a mean shell thickness of 0.44 mm (0.40-0.49; n=24), another 0.34 mm (0.31-0.36; n=13), and the smallest 0.26 mm (0.24-0.29; n=7).

The shells exhibited a structure typical of birds (TYLER [12], BOARD *et al.* [2]) and not of tortoises, of which shells with similar thickness values were found in Miocene sediments of Lanzarote, Canary Islands (HUTTERER *et al.* [6]).



Fig.2. Possibly procellariiform egg discovered in the miocene sediments of Selvagem Grande in 1999.



Fig.3. Fossil bones at site 2.

Bones

Very few and fragmented bones could be rescued from the hard matrix. All are very fragile, and very few diagnostic features are preserved (Fig. 3)

Skull. - Fragments of the anterior portions of a bill were found in the same matrix (fig. 4). In shape and size, the bill resembles that of *P. puffinus* but is slightly larger. The bill was found in close association with a mandible fragment (fig. 5), which again was compared to *P. puffinus* and was found to be slightly more robust. A quadratum was also found (fig. 6); in comparison to *P. puffinus* it is also more robust, and the mandibular processi are larger.

Postcranial skeleton. - A fragmentary right radius and a left ulna are in the size range of *P. puffinus*. There is also a left carpometacarpus in the *puffinus-mauretanicus* size range. One phalanx I is larger, and three terminal phalanges are much smaller than in these shearwaters.

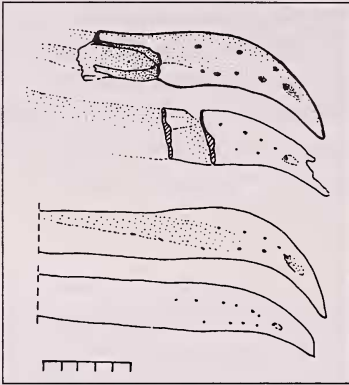


Fig. 4. Fragment of a bill (tips of os premaxillare and os dentale) found embedded in matrix of the Miocene sediments of Selvagen Grande. Corresponding parts of an extant *Puffinus puffinus* are shown below. Scale represents 5mm.

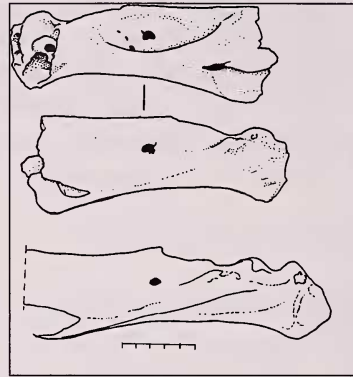


Fig. 5. Proximal part of a left mandible in medial and lateral view; a mandible of *Puffinus puffinus* is shown below for comparison. Scale represents 5 mm

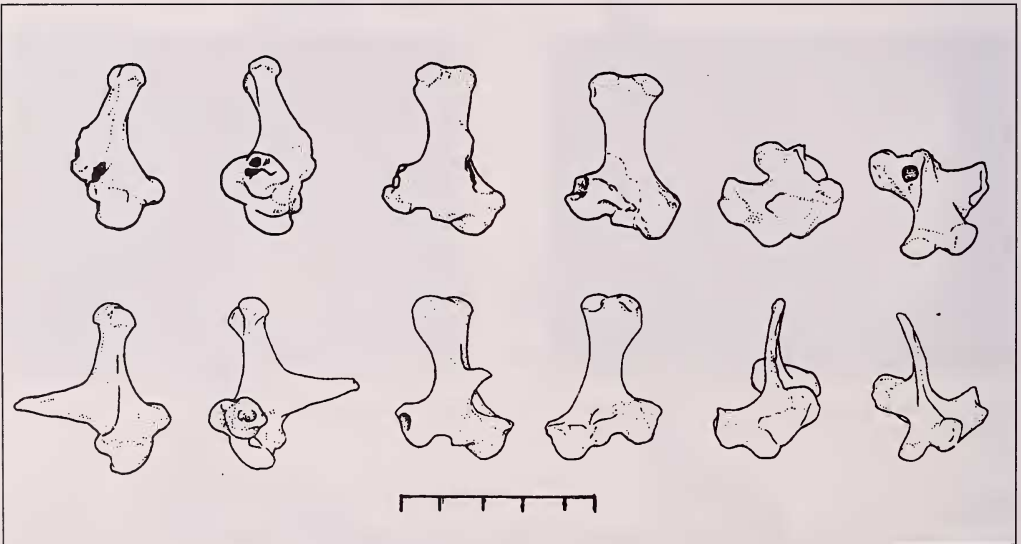


Fig. 6. Six views of a quadratum from the Miocene sediments of Selvagem Grande (top), compared with a quadratum of *Puffinus puffinus* (below). Scale represents 5 mm.

4. DISCUSSION

The eggshell remains suggest that three different species of birds bred on Selvagem Grande in the Miocene. There is no proof that these fragments represent procellariid birds,

but if taking this as granted, then the sample with the thickest shell (0.44 mm) could perhaps correspond to *Fulmarus* (0.39-0.41 mm) or *Diomedea* (0.52 mm), the medium-sized sample (0.34 mm) to *Puffinus mauretanicus* (0.32 mm) or *Calonectris borealis* (0.35), and the small sample (0.26 mm) to *Puffinus puffinus* (0.28 mm), *P. yelkouan* (0.29 mm) or *P. assimilis* (0.23) (data of extant birds taken from SCHÖNWETTER [10]). *Pelagodroma*, *Bulweria*, *Hydrobates* and *Oceanodroma* have much thinner eggshells (SCHÖNWETTER [10]). The complete egg from Site 1 could well correspond to *Puffinus puffinus* or *P. yelkouan*, and may be equally represented by the thinnest shells from Site 2. Both values plot neatly in WARHAM'S ([15]: 295) diagram of shell thickness and egg size. Alternatively, the medium-sized sample could represent eggs of *Larus cachinnans* (0.31 mm), a species currently breeding on the islands (BACALLADO & OROMÍ [1]). However, eggs of *Larus cachinnans*, *L. argentatus* and other species are much larger than the fossil egg reported here.

The bone fragments suggest that a species similar to *Puffinus puffinus* was present; however, the generic identification is not secure. Remains of *Puffinus* cf. *puffinus* were recorded by OLSON & RASMUSSEN [9] from the Miocene of North Carolina, and about 10 fossil species of *Puffinus* were named from the Miocene of Europe and North America (OLSON [8]), often on the basis of very fragmentary material. No procellariiform bird has been recorded from the Miocene of the Atlantic islands before. The only Miocene bird remains reported from any other Atlantic island before are large eggs and a small piece of bone found in Lanzarote (GARCÍA-TALAVERA [5]); these fossils have alternatively been identified as struthionid, aepyornithoid, or odontopterygiform birds.

However, from Pleistocene and Holocene sediments of Madeira, the Canary Islands, and St. Helena various extinct species of *Puffinus* have been described (see OLSON [7] and TYRBERG [13]).

There is also some evidence that other smaller species of birds are represented in the bone fragments from Selvagem Grande, but no diagnostic bones were found so far.

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Site 1.



Site 2.



General view of the "miocenic sediment complex"